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Neuronavigational assisted ventriculo-peritoneal shunt surgery in the idiopathic intracranial hypertension (IIH) patients. Institutional experiences

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Keywords
hydrocephalus, idiopathic intracranial hypertension, neuronavigation, ventriculoperitoneal shunt

ABSTRACT

Object. Lumboperitoneal shunt are commonly used for idiopathic intracranial hypertension (IIH) because of the difficulty of insertion of Ventriculoperitoneal (VP) shunt into normal or small-sized ventricles. The authors showed their experience with VP shunts for IIH with the help of a Neuronavigation system.

Methods. This is a retrospective study of 16 patients of IIH in whom Neuronavigation was used to guide the insertion of a shunt in the ventricle for IIH at our institution. A trial of either acetazolamide or steroid therapy had failed in all patients.

Results. Shunt placement was successful and uncomplicated in each case except for one patient in which shunt failure occurred (6.25%) post-operatively. Outcomes were assessed at 12 months which were favourable regarding symptoms 13 cases (81.25%) got relief in headaches and 4 patients (25%) showed improvement in vision. Misplacement of the shunt occurred in one case postoperatively and Shunt failure occurred in 2 cases (12.50%) during the follow-up period due to ventricular end obstruction. These three patients required shunt revision. Progression of the visual deficit did not occur.

Conclusion. Our results suggest that the Neuronavigation-guided ventriculoperitoneal shunt is a good alternative to Lumboperitoneal shunt in IIH patients.

INTRODUCTION

Benign intracranial hypertension(BIH) also known as Idiopathic intracranial hypertension (IIH) or Pseudotumor cerebri is a disorder of raised ICP in the absence of any secondary pathology in radiological imaging(1,2,3). Empty Sella syndrome, lateral sinus collapse, flattened globes and fully unfolded optic nerve sheaths are signs of increased intracranial pressure, as seen in imaging.

This disorder is more common occurred in young (mainly in childbearing age), obese and female sex (4,5).

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The signs and symptoms of intracranial hypertension include headache, tinnitus (pulsatile tinnitus), transient visual obscurations and visual loss. Neurological examination is normal except for diplopia, sixth cranial nerve paresis and papilledema. Visual loss is the major morbidity in IIH.

There are multiple treatment options for IIH. Start as conservative to end as a surgical procedure. The initial treatment of choice is Acetazolamide which provides symptomatic relief (6,7,8,9). Steroid therapy is also used when patients do not get relief from medicine, conservative treatment fails, or significant visual loss, progressive visual loss or severe headache then surgical treatment is needed. Possible surgical modalities are Optic nerve sheath fenestration and CSF diversion procedure. Two CSF diversion methods exist (1) LP shunting and (2) VP shunt placement. LP shunt placement is a more commonly performed procedure than VP shunt because difficulty inthe insertion of the catheter into small-size or normal-size ventricles (5,10,11,12,13,14).

However, after the development of IGN (image-guided Neuronavigation) the introduction of the catheter into the ventricle is not difficult. Our study is based on Neuronavigation-based VP shunt in IIH patients.

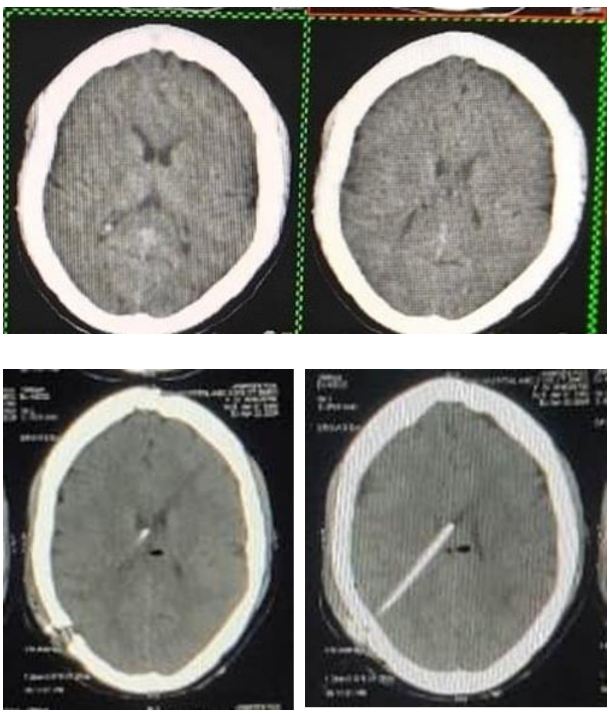

Figure 1. Pre-operative NCCT Head (A & B) and Post Operative NCCT Head (C & D).

What is neuronavigation and steps

Neuronavigation is a tool used during brain surgery to locate where in the brain the surgeon is working i.e. intraoperative orientation. The navigation is based on preoperative MR /CT images, which are merged to build a 3D view that is displayed on a computer workstation. Neuronavigation are techniques which help Neurosurgeons to precisely localize the different intracerebral pathology.

Each Neuronavigation system follows the same steps for the surgical procedure:

- Obtaining preoperative images (CT, MRI) and images can be transferred in the navigation system via computer network)
- Patient registration,
- Intraoperative localization;
- Intraoperative control;
- Obtaining intraoperative images and fusion with preoperative ones;
- Visualization and surgery

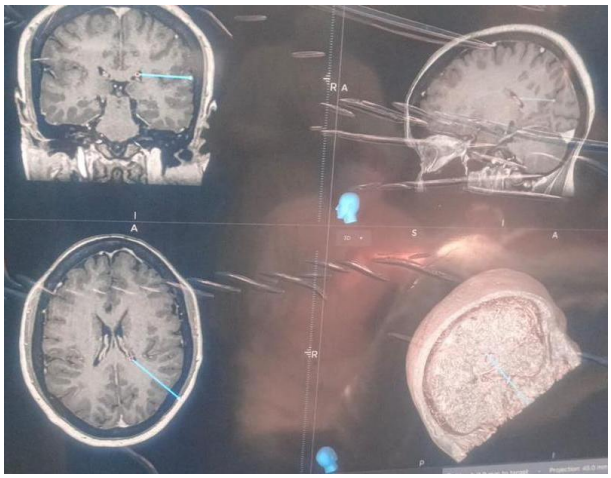

Figure 2. Planning of trajectory of shunt before surgery with help neuronavigation in axial, sagittal and coronal views.

Material and methods

This is a retrospective study of 16 patients of IIH in whom VP shunting was done with the help of Neuronavigation at Neurocare Hospital Jaipur from 2018 to 2023. The diagnosis of IIH was made by an author who is a neurosurgeon, based on the history, clinical symptoms, neurological examination and imaging studies. ICP measurements were also done in some cases when available. Fundus examination was done by an ophthalmologist in every case. Laboratory evaluation in IIH patients is normal except for increased intracranial pressure. All

patients had taken medical treatment including steroids and acetazolamide, but did not get relief. All shunts were placed under the guidance of the Neuronavigation system. Shunt placement grading is done in each case by CT scan.

Figure 3. The navigation stylet is used as the catheter trocar.

Inclusion criteria

All patients of IIH with failed response to medical treatment.

Surgical technique

After explaining the pros and cons, the patient is shifted to the operation theatre. After general anesthesia, patients are placed in a supine position with their heads tilted toward the opposite side. After system registration, the surgical plan was made from the entry site to the final tip position of the catheter (figure 2). After proper sterilization, the entry point is marked with the help of Neuronavigation. C-shaped skin flap raised and burr hole made. The peritoneal catheter is passed subcutaneously and placed in the abdomen. Dura is coagulated.The proximal end of the shunt was inserted with the help of a catheter stylet of the Neuronavigation system (figure 3) and confirmed in all planes (axial, coronal and sagittal). We are using the MEDTRONIC optical system. Once the proximal catheter is in place, it is connected to the peritoneal end. Both wounds closed in layers.

Patients attended a follow-up visit at 1 month, 6 month and 12 months and asked about vision, headache and any other symptoms. No patient was lost to follow-up.

Results

In our study, we included 16 patients in whom this procedure was performed between 2018 and 2023. Therewere 12 females and 4 males; their mean age was 33.06 years (range 22–44 years). Most of the women were in the reproductive age group and the mean BMI was 26.42 that is most of the patients were overweight.

In our study symptoms and signs common in most of the patients were headache, blurred vision and tinnitus. Diplopia and visual loss were less common. Headache and blurred vision were usually presenting symptoms. Papilloedema and sixth nerve paresis are also a common finding in IIH.

Assessment of effectiveness

Postoperatively, CT brain was done in every case and assessment of the tip of ventricular catheter for grading of shunt placement was done.

Grade I; Catheter tip position free-floating in CSF, away from ventricular wall or cho¬roid plexus (Figure1).

Grade II; Catheter tip touching choroid plexus or ventricular wall.

Grade III; Tip within parenchyma or failure to reach the intraventricular space.

Grade 1 shunt placement was found in 11 (68.75%) patients, and grade II shunt and grade III shunt placement were found in 4 (25%) and 1 (6.25%) patients respectively. According to shunt placement the shunt failure rate was 6.25 %. Shunt revision was done in grade III shunt placement.

Outcome-Outcomes were assessed at 12 months which were favorable regarding symptoms.13 cases (81.25%) got relief in headache and 4 patients (25%) showed improvement in vision. Shunt failure occurred in 2 cases (12.50%) at 12 months due to ventricular end obstruction. (table 1)

Complication –There was no immediate or early complication seen (no ICH, no IVH, no infection) except misplacement ofthe ventricular end in one case. Proximal end obstruction was seen in 2 cases (12.50 %) during the follow-up period.

Discussion

There are multiple treatment options for IIH including drugs (steroids, acetazolamide, weight loss) optic nerve fenestration, lumbar peritoneal shunt and ventriculoperitoneal shunt.

Optic nerve sheath fenestration-related complications are peripapillary hemorrhage, papillary dysfunction, and strabismus. Death, worsening of visual field deficits, permanent loss of vision,and stroke are rarely reported complications of the Optic nerve sheath fenestration procedure (15,16,17,18). Shunts are more effective than optic nerve sheath fenestrations for relieving headaches because shunt procedures lower ICP (19).

The use of LP shunts for IIH has been well-described in many studies (12,20,21,22).

According to the different literature, LP shunt surgery is associated with multiple complications such as a high rate of obstruction-related shunt failure (10,14). intracranial hypotension resulting from excessive drainage of CSF (10,12,14,24).

Table 1. Table showing sixteen patients, with their symptomatology, grading of shunt and outcome at 1 year.

Case no	**Age/ sex**	**Symptoms & sign**	**Fundoscopy** (papilledema)	**Grade of shunt placement**	**outcome**		
					Headache	Vision	Obstruction
1	35/f	B/V, H/A	+ (Present)	GRADE 1	NO	IMPROVED	
2	32/f	B/V, H/A	+ (Present)	GRADE 2	YES	STABLE	Proximal end obstruction
3	44/f	B/V, H/A	+ (Present)	GRADE 1	NO	STABLE	
4	22/f	B/V, H/A	+ (Present)	GRADE 3	NO	STABLE	
5	44/m	B/V, H/A	+ (Present)	GRADE 1	YES	STABLE	
6	38/m	B/V, H/A	+ (Present)	GRADE 1	NO	IMPROVED	
7	26/f	B/V, H/A	+ (Present)	GRADE 1	NO	IMPROVED	
8	37/f	B/V, H/A	- (Absent)	GRADE 1	NO	STABLE	
9	37/f	B/V, H/A	+ (Present)	GRADE 1	NO	STABLE	
10	42/f	B/V, H/A	+(Present)	GRADE 1	NO	IMPROVED	
11	26/f	B/V, H/A	+(Present)	GRADE 2	NO	STABLE	Proximal end obstruction
12	28/f	B/V, H/A	+(Present)	GRADE 1	NO	IMPROVED	
13	32/m	B/V, H/A	- (Absent)	GRADE 1	NO	STABLE	
14	26/f	B/V, H/A	+(Present)	GRADE 1	YES	STABLE	
15	32/f	B/V, H/A	+(Present)	GRADE 2	NO	STABLE	
16	28/m	B/V, H/A	+(Present)	GRADE 2	NO	STABLE	

B/V = blurred vision, H/A = Headache

Lumbar radiculopathy (23, 24). and Tonsillar herniation is also reported following LP shunt placement (25).

According to some literature, the ventriculoperitoneal (VP) shunt was superior to the Lumboperitoneal (LP) shunt in IIH with better clinical outcomes. However,Ventricular shunts are infrequently used in IIH because of the difficulty in placement of a shunt in a small-sized or a normal-sized ventricle with a fear of misplacement of the catheter. VP shunt malfunction is often caused by ventricular end obstruction (26,27). Hence, accurate placement is one of the most important predictors of shunt survival (28). The ventricular catheter insertion, in cases of IIH, has been considered technically challenging and this may require Neuronavigation insertion.In our study, we are using medtronic optical system navigation and the results are favorable regarding the effectiveness of shunt placement as well as resolving of symptoms. Our study aims to establish VPS surgery in the case of IIH with the help of Neuronavigation. The disadvantages

of navigation systems are time-consuming, expensive, and not easily available. The limitation of this study was that there were no comparison groups of VPS and LPS in cases of IIH.

Conclusion

Our results support Neuronavigation-guided VP shunt placement as an effective and durable treatment option in cases IIH with a low incidence of complication rates.

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